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(71) Applicant(s)
Swintex Limited

(Incorporated in the United Kingdom)

Derby Works, Manchester Road, BURY, Lancs, BL9 9NX, United Kingdom

(72) Inventor(s)
Harry Vincent Houghton

(74) Agent and/or Address for Service
Wilson Gunn M'Caw & Co.
41-51 Royal Exchange, Cross Street, MANCHESTER, M2 7BD, United Kingdom

(54) Retro-reflective road traffic furniture

(57) A retro-reflective device e.g. a road cone, comprises a white retro-reflective portion and at least one further retro-reflective portion displaying a blue or red colour. The white retro-reflective portion has a performance of less than 180 cd/lux/m^2 and the coloured portion has a performance of at least 10 cd/lux/m^2 when blue and of at least 15 cd/lux/m^2 when red. Such performance is measured in accordance with the requirements of British Standard 873 parts 6 and/or 8 (1983) at an entrance angle of - 5° and an observation angle of 20'.

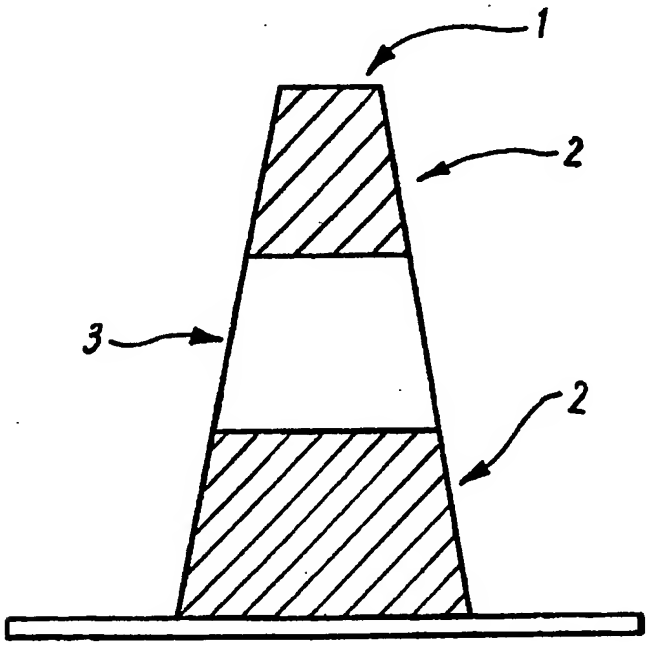

FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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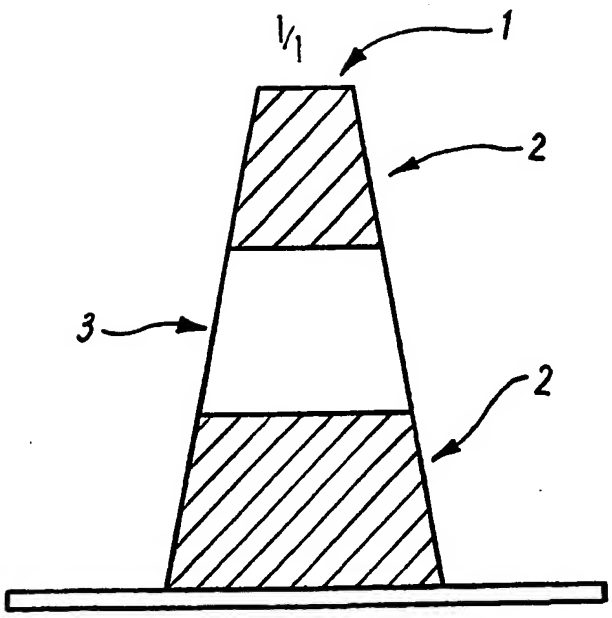

FIG. 1

FIG. 2

This invention relates to improvements in the visual effectiveness of retro-reflective road traffic signs, delineators, barriers, bollards, cones, markers and the like in general, but is particularly beneficial when applied to temporary use products at sites such as road works, accidents or emergency situations.

There are technical standards in force in different countries that define the colours; the brightness of colours (hue, intensity, luminance) for day time use, and the retro-reflective performance of the sign surfaces at night. Such standards include BS:873 Parts 6 and 8, DIN 67/520, and allied safety sign standards such as ISO 3864 - 1984 which stress contrast, and CIE documents such as 39-2 and CIE 72. Generally, these standards have been developed to give satisfactory technical performance to permanent traffic signs, which normally are intended to provide information, often in the form of contrasting text and which are usually positioned away from close proximity to drivers. Due to the relatively large size of such permanent signs, the area of a given colour present on the sign as either background, border or text is such that when the area value, combined with the contrast value for the two colours is viewed, the message, legend or pictogramme presented is readily discernible to the human eye in daylight. Similarly but occasionally to a lesser degree, at night time, the retro-reflective image present, performs adequately for an informative purpose, although often, the legibility or distance to comprehension is achieved by

difference in relative brightness rather than difference in actual colour i.e., whilst in daylight, a driver will readily perceive a white legend against a blue background as "a white legend against a blue background". At night time, the driver will frequently be firstly aware of a "bright legend against a darker background" followed by at a closer distance "a bright white legend against a less intense blue background".

Generally, such permanent signs are mounted in a position to one side or above the drivers' line of travel such that the driver is required momentarily to direct his/her line of sight a small part up or to the side to directly view the sign. At night, this is often sufficient to reduce the effect of glare from oncoming vehicles' headlights, or glare produced from lights in rain or vehicle spray, rendering the sign more visible than it would be if it was mounted at road level in an area substantially ahead of the driver.

It has been found that background night time glare close to, or behind a sign, or in the approximate direct line of sight, between a driver and a sign, reduces the effectiveness of the sign and particularly, it reduces the conspicuity of the darker colour present in the sign (i.e. the red on a red bordered sign and the blue on a blue grounded sign with white legend). The effectiveness of the white portion or brighter colour is also reduced but to a lesser degree.

Taking one of the standards previously referred to as an example of required performances of retro-reflective signs, the following extract from BS:873 Part 6 1983 tables 1, 2 and 5 shows the typically accepted levels of retro-reflectivity and luminance for different permitted and defined colours similarly described in table 4 of the Standard, and is introduced for reference.

Extract from Tables 1 and 2 - BS:873 Part 6 1983

Road Traffic Signs

Table 1 - Class 1 Retro-reflective material

Entrance angle	Observation angle	Minimum coefficient of retro-reflection cd/lux/m²				
		Red	Yellow	Green	Blue	White
-5°	12′	35	170	20	20	250
	20′	25	120	14	14	180
+40°	20′	13	65	5	7	95

Table 2 - Class 2 Retro-reflective material

Entrance angle	Observation angle	Minimum coefficient of retro-reflection cd/lux/m²				
		Red	Yellow	Green	Blue	White
-5°	12′	12	50	5	4	70
	20′	10	35	5	3	50
+40°	20′	2.5	5	1	0.8	10

Extract from Table 5 BS:873 Part 6/1983 Luminance Factors

Colour	Luminance Factors for Retro-reflective Materials	
Red	0.03 min	0.11 max
Yellow	0.16	0.40
Blue	0.01	0.10
White	0.25	--

Findings relating to night time temporary sign performance

In daylight, one skilled in the art of sign design will realise that a sign complying with the Class 2 table above having a blue background with white legend will have a minimum contrast ratio of the luminance factors 0.10 to 0.25 respectively to comply with the standard and in practice, this is often 0.06 to 0.35 or more respectively. In daylight, the colour perception is satisfactory, giving strong contrast ratios and good colour difference.

However, at night, the driver relies on retro-reflectance and the minimum red or blue colour Class 2 retro-reflective performance is less effective than daytime colour being for a Class 2 performance sign blue - 3 cd/lux/m^2 to white 50 cd/lux/m^2.

In practice, it was found that a sign comprised of a blue ground was not sufficiently bright in the case of a Class 2 sign for the blue colour to be reliably visible at distance unless the sign was placed out of areas of background glare.

It was also found that a similar sign with a blue ground but to Class 1 performance whilst improved in its blue conspicuity, could itself generate white glare at undesirable levels if placed within the line of travel such that headlights shone directly on to the sign and consequently, the white portions retro-reflecting the headlights directly back to the drivers' eye at high levels of retro-reflectance caused excessive glare. (It should be noted that whilst the Standard for Class 1 signs calls for a minimum of 180 cd/lux/m² at -5°/20', materials are commercially available which exceed Class 1 values and can have performances substantially higher, even as high as 300 cd or even 1000 cd/lux/m²).

Similar results were found when a red ground was substituted for a blue ground.

The above observations are particularly relevant to signs placed in close proximity to the line of vehicle travel i.e., at road works, or at accident sites or other temporary diversions.

<u>Findings relating to the visual performance of delineators such as road cones at night</u>

Most countries have specified in codes of practice or other national regulations or guidelines that road cones or delineators shall have a white retro-reflective portion applied that meets the minimum requirements of BS:873 Part 6 Class 2 (Table 2 above) - or its national equivalent.

In some countries, this is not necessarily considered to be wholly satisfactory on its own and in Germany, for instance, requirements have been up lifted to include that the red portion of a cone shall also be retro-reflective, at the equivalent of BS:873 Part 6 Class 2 referred to in DIN 67/520. (i.e., DIN 67/520 Type 1).

This came about from the observation that road cones constructed with only a single white band or several bands of white retro-reflective material bordered by orange or red non retro-reflective material (the plastic body of the cone) gave different visual presentations to the driver in daylight versus night time.

In daylight, the driver observed a conical shape which had a readily visible red or orange ground (especially if the orange/red was fluorescent) with one or more contrasting white coloured bands.

At night time however, the visual effect was largely limited to that of one or more white (retro-reflective) coloured bands. The conical shape and the background non retro-reflective body colour only becoming evident at close range.

It was considered that by requiring that the red (orange/red is only acceptable for daytime non retro-reflective surfaces) portion should also be retro-reflective that this would provide the same visual message at night time as the device did in daytime.

However, in trials, it was observed that the addition of red areas conforming to the basic Class 2 BS:873 Part 6 equivalent of retro-reflective materials on the road cone to German requirements did not have as marked an effect on night time conspicuity as expected. Examples of products manufactured to meet the 1992 fully reflective red/white German specification manufactured by Molan Werk GmbH were examined and were found to have the following characteristics of retro-reflective performance, and colourimetric characteristics (Dec. 1992).

White Portions	65 cd/lux/m²	} measured at -5°/20'
Red Portions max	10 cd/lux/m²	} using MAP Photometer

Luminance (Y)	0.07	} CIE/045 D65-Y,x,y
Red Colour (x)	0.6495	} as measured on X-Rite
(y)	0.3198	} Spectrophotometer

This product type is representative of white sign sheetings over printed with a proprietary red ink and it was observed that the red portion was not as striking to the eye at night as may be desirable. The effect was an improvement in clear dry conditions with minimal traffic flow and no street lighting (i.e., optimal night driving conditions) but in dense traffic flow with increased glare and in wet conditions, the benefit was much reduced.

The application of much brighter white retro-reflective surfaces in excess of 180 cd/lux/m² had similar glare disadvantages as those experienced in signs especially when the cones/delineators were used in high densities.

The effectiveness of the typical Class 2 performance coloured materials was found to be most inadequate at dusk or dawn with the sun behind the sign/cone/delineator, in these conditions, the red portions were barely discernible, even at relatively short distance.

The characteristics of this problem are markedly different from the problems experienced with permanent road signs. which are purposely displaced from the driver, eliminating the glare experienced by drivers were such a sign to be placed in the direct line of travel at road level. It was with these problems in mind that this invention was made.

According to the invention there is provided a retro-reflective device comprising a white retro-reflective portion and at least one further retro-reflective portion displaying a blue or red colour, wherein the white retro-reflective portion has a performance of less than 180 cd/lux/m^2 and the coloured portion has a performance of at least 10 cd/lux/m^2 when blue and of at least 15 cd/lux/m^2 when red, said performance being measured in accordance with the requirements of British Standard 873 parts 6 and/or 8 (1983) at an entrance angle of -5° and an observation angle of 20'.

The invention rests on the discovery that a much improved visual performance at night could be achieved without detriment to daylight appearance by means of applying retro-reflective surfaces to the signs/cones/ delineators which were of different retro-reflective performance. It was found that the application to a sign of a Class 1 (BS:873 Part 6) blue ground material with white legend to the basic requirements of Class 2 (BS:873 Part 6) (i.e. approximately 60 cd/lux/m^2) gave much earlier colour recognition and marginally less legibility at night than an overall Class 2 equivalent without the potential glare experienced using Class 1 white legends.

This effect was experienced similarly for red ground with white legend and for red and white cones and delineators.

In examining the traditional products available in France, Germany, the U.K. and in the U.S.A., we examined those road cones offered by Manzer (F), Molan (G), Johnstone Safety (UK), Melba Ltd (UK), Peter Cook PLC (UK) and Services and Materials (USA) together with temporary sign products manufactured by Quazar Signs U.K. and a wide variety of temporary signs in use in France and Germany of unknown manufacture, comprised of retro-reflective materials originating from the 3M Corporation of the U.S.A., the Reflexite Corporation of the U.S.A. and Seibulite of Japan. Without exception, all products made up as finished signs or devices were comprised of materials in which all colours present (including white) were to either Class 1 or Class 2 BS:873 categories (or their equivalent in other standards) OR the white portion was of a higher category (i.e., Class 1) with the coloured portions being of Class 2, or the white portion was to Class 2 and the coloured portion was of a performance lower than that required by Class 2 table, or there was only a white retro-reflective portion present.

No product has been found where the white portions are Class 2 and the coloured portions are Class 1.

This is of particular relevance to those product areas which are comprised of flexible materials such as "roll up" flexible signs or two coloured sleeves for cones, delineators or markers for these are often used in emergency or road works situations.

In a preferred embodiment of the invention the performance of the blue coloured retro-reflective portions is at least 14 cd/lux/m^2 and that of the red portion at least 25 cd/lux/m^2.

The device may be assembled from different pieces of different colour. Alternatively the device may be a single piece of material in which different colours are provided covering a retro-reflective substrate with an appropriately coloured transparent or translucent coating. For example the retro-reflective substrate can be covered by a transparent layer such as of plastics, printed or coated on one or both surfaces with the desired colour. The retro-reflective device may comprise glass microspheres or microprisms or a combination thereof. The device can be rigid or flexible.

Here are now described preferred embodiments of this invention -

Fig.1 illustrates a road cone whereby the conical upright portion (1) is covered in retro-reflective material such that the upper portion (2) and lower portion (2) are red as defined in BS:873 Part 6 1983, and have a retro-reflective performance in excess of 25 cd/lux/m² when measured in accordance with BS:873 Part 6 1983 at entrance -5°/20′ observation, and a centre portion (3) which is white as defined in the same standard, having a retro-reflective performance when similarly measured of less than 180 cd/lux/m² but preferably in the 100 to 170 cd/lux/m² range.

Figure 2 shows a sign (4) where a ground (6) which is blue as defined in BS:873 Part 6 1983 has a retro-reflective performance greater than 14 cd/lux/m² when measured at entrance -5°/observation 20′ as defined in the same standard, and which also has a legend or design in white (5) (as defined in the same standard) which has a retro-reflective performance of less than 180 cd/lux/m² but preferably in the 100 to 170 cd/lux/² range.

Either of the examples given above and illustrated in figures 1 and 2 can be manufactured by applying separate pieces of material of different retro-reflective performance but this is time consuming and difficult to achieve, especially if the final product is intended to be flexible, without joins, and minimum cost.

To overcome this particular problem, it was found that the following method can be more beneficially employed. The example/method described is for red and white, but it may just as readily be employed for blue/white.

A substrate sheet of 250 microns thick plasticised PVC sheet which was reinforced with woven textile was coated using known art with a white binder layer onto which was cast and partially embedded, a layer of glass microspheres of between 54 and 120 microns diameter , the said beads having a coating of metal, the metal layer not embedded in the binder layer then being removed by known techniques. The proportions of beads present being sufficient to provide a retro-reflective performance of 120 cd/lux/m^2 when covered with a clear PVC top layer. All this is known art.

The said top clear layer was, prior to being introduced to the substrate layer, coated in the desired areas with a transparent red lacquer having the minimum visible light absorption characteristics so that when laid over the substrate, the portion not coated red would retro-reflect light at the desired 120 cd/lux/m^2 and the portion coated red would retro-reflect light at greater than 25 cd/lux/m^2 . Such a coat comprised of Marler Red screen printing lacquer thinned slightly more than normal by the addition of a standard thinner.

The resultant product had the following characteristics.

Colourimetric and Photometric performance of two sample road cone sleeves made up of red and white portions as one piece as described above

Colour co-ordinates (CIE 0/45°-D65 Y, x, y measured using X-Rite Spectrophotometer type 968)			
Sample 1	x	y	Y (luminance factor)
RED	0.6087	0.3356	0.0945
WHITE	0.3225	0.3410	0.3650
Sample 2			
RED	0.6131	0.3360	0.0924
WHITE	0.3222	0.3410	0.3740

Photometric Performance - cd/lux/m² when measured in accordance with BS:873 Part 6 1983 at entrance angle -5°, observation angle 20′	
Sample 1	
RED	25.9
WHITE	120.3
Sample 2	
RED	24.8
WHITE	114.7

Similarly, an example of a blue flexible sign with white lettering was made up in the same way using a similarly thinned blue Marler ink, which had the following colourimetric and photometric properties.

Colourimetric and Photometric performance of two sample road signs made up of blue background with white legend as described above

Colour co-ordinates (CIE 0/45°-D65 Y, x, y measured using X-Rite Spectrophotometer type 968)			
Sample 3	x	y	Y (luminance factor)
BLUE	0.1409	0.2034	0.0940
WHITE	0.3225	0.3410	0.3650
Sample 4			
BLUE	0.1400	0.1999	0.0910
WHITE	0.3222	0.3400	0.3800
Photometric Performance - cd/lux/m² when measured in accordance with BS:873 Part 6 1983 at entrance angle -5°, observation angle 20′			
Sample 3			
BLUE	20.9		
WHITE	111.0		
Sample 4			
BLUE	22.8		
WHITE	119.5		

In other embodiments or examples, the top cover may be joined to the substrate at the edges and/or at other desired points by adhesive means or welding, for example by high frequency radio energy or by ultrasonic sound.

The substrate and top cover do not need to be flexible as any suitable substrate and top cover may be employed.

Other examples were prepared with white base material performance in the 150/175 cd/lux/m² range with commensurate red performance levels, but the illustrations

given above were found to be satisfactory in visual performance and economical to manufacture.

For practical reasons of quality assurance, it was found to be increasingly difficult to achieve a Class 1 red or blue from a common base white at performance levels where the white is less than 90 cd/lux/m², (at -5°/20') but for the purpose of this invention, such exploitations are not excluded.

Also, although the examples quoted are for microsphere based materials, the principles hold equally well for microprismatic or corner cube type retro-reflective materials.

The embodiments described are air incident microsphere materials, but the principle is equally suited to encapsulated non air incident materials.

The invention is particularly useful for marking or delineating hazards on the road, such as roadworks, an accident or the like. The higher performance of the coloured part of the assembly means that the said coloured part will be visible to the driver of an oncoming vehicle while still at a considerable distance away. Moreover the fact that a colour is being perceived, not just white, alerts the driver that something out of the ordinary is ahead.

The invention is not limited to the specific embodiments described and there are many other variations which may be employed by those skilled in the art.

CLAIMS

1. A retro-reflective device comprising a white retro-reflecting portion and at least one other retro-reflecting portion of a blue or red colour, wherein the white retro-reflecting portion has a performance of less than 180 cd/lux/m^2 and the coloured portion has a performance of at least 10 cd/lux/m^2 if blue, and 15 cd/lux/m^2 if red, when measured in accordance with the requirements of BS:873 Part 6 and/or 8 at entrance angle -5°/observation angle 20'.

2. A retro-reflective device as claimed in Claim 1, wherein the blue coloured portion has a performance of at least 14 cd/lux/m^2.

3. A retro-reflective device as claimed in Claim 1 or Claim 2, wherein the red coloured portion has a performance of at least 25 cd/lux/m^2 by covering a retro-reflective substrate with a substantially transparent, appropriately coloured coating.

4. A device as claimed in any preceding claim, wherein separate pieces of material provide different coloured portions.

5. A device as claimed in any preceding claim, wherein different coloured portions are provided.

6. A device as claimed in Claim 5, wherein the coating is provided on one or both surfaces of a transparent or translucent layer.

7. A device as claimed in any preceding claim comprising glass microspheres.

8. A device as claimed in any preceding claim comprising microprisms.

9. A device as claimed in any preceding claim, wherein the device is flexible.

10. A sign or guidance device intended for use at road construction, or deviation points or for use by emergency services comprising a retro-reflective device as claimed in any preceding claim.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report) -20-

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Relevant Technical fields

(i) UK Cl (Edition L) E7G

(ii) Int Cl (Edition 5) E01F

Search Examiner
D HAWORTH

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WORLD PATENTS INDEX

Date of Search
21 APRIL 1993

Documents considered relevant following a search in respect of claims

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2171440 A (GLASDON)	1-6 and 10

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

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